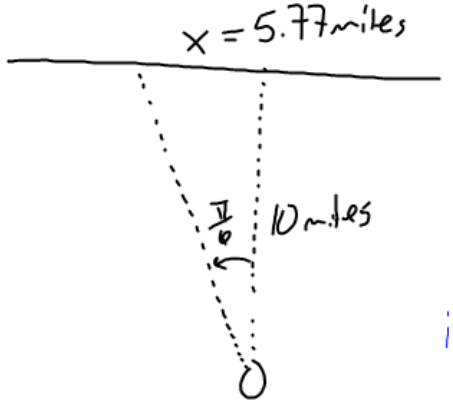
A search light rotates at a rate of 3 revolutions per minute. The beam hits a wall 10 miles away and produces a dot of light that moves horizontally along the wall. How fast is this dot of light moving when the angle between the beam and the line through the search light perpendicular to the wall is $\frac{\pi}{6}$?



$\tan\theta = \frac{x}{10}$

$x = 10\tan\theta$

$\frac{dx}{dt} = 10\sec^2\theta\frac{d\theta}{dt}$

$10\left(\sec^2\left(\frac{\pi}{6}\right)\right)\cdot 6\pi$

$\frac{dx}{dt} = 251 \text{ miles/min} = 15{,}060 \text{ mph}$

look 0.1 sec later

in 1 sec $\frac{\pi}{10}$ radians

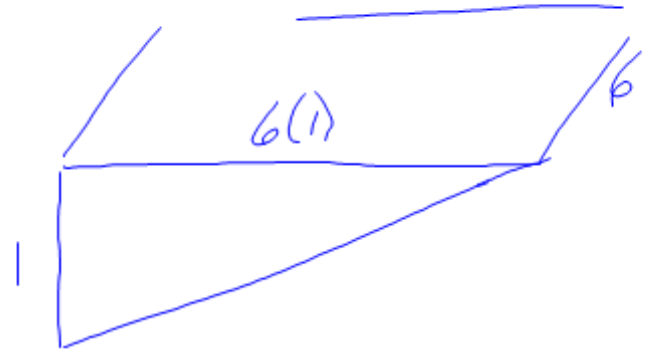
in 0.1 sec $\frac{\pi}{100}$ radians

$x = 10\tan\left(\frac{\pi}{6} + \frac{\pi}{100}\right)$

$x = 6.20$

$\frac{dx}{dt} = \frac{6.2 - 5.77}{0.1} = 4.3 \text{ miles/sec}$

$\approx 15{,}489 \text{ mph}$



$V = \frac{1}{2} h \cdot 6h \cdot 6$

$V = 18h^2 \longrightarrow h = \sqrt{\frac{V}{18}}$

$V = 18\,m^3$ at $h = 1\,m$

1 sec later

$\frac{1}{4}\,m^3/min \div 60 = \frac{1}{240}$

New volume

$18 + \frac{1}{240}$

New height

$$\sqrt{\frac{18 + \frac{1}{240}}{18}}$$

$\approx 1.0001157\overline{34}$

$$\frac{0.0001157\overline{34}}{1\,sec.} \cdot 60 = \frac{dh}{dt} \approx 0.00694$$

Finish

#17 in 4.6

Do

#18, 20, 21